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(54) Transporting cementous material through a pipe for example at a coal mine

(57) Cementitious grout is inserted into a pipe (22) and a mixture of aggregate and water is then inserted into the pipe (22), both components being transported together along the pipe (22) with the cementitious grout leading and the aggregate and water following. The aggregate and water cleans the pipe (22) and prevents any cementitious grout hardening on the internal wall of the pipe. The cementitious grout and aggregate is transported by air pressure from the ground surface to a mine face area where it is used to cast walls to support the mine roof.

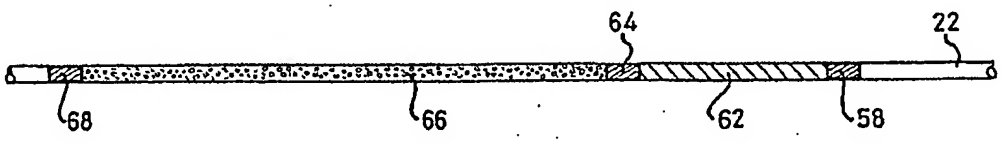

Fig.3

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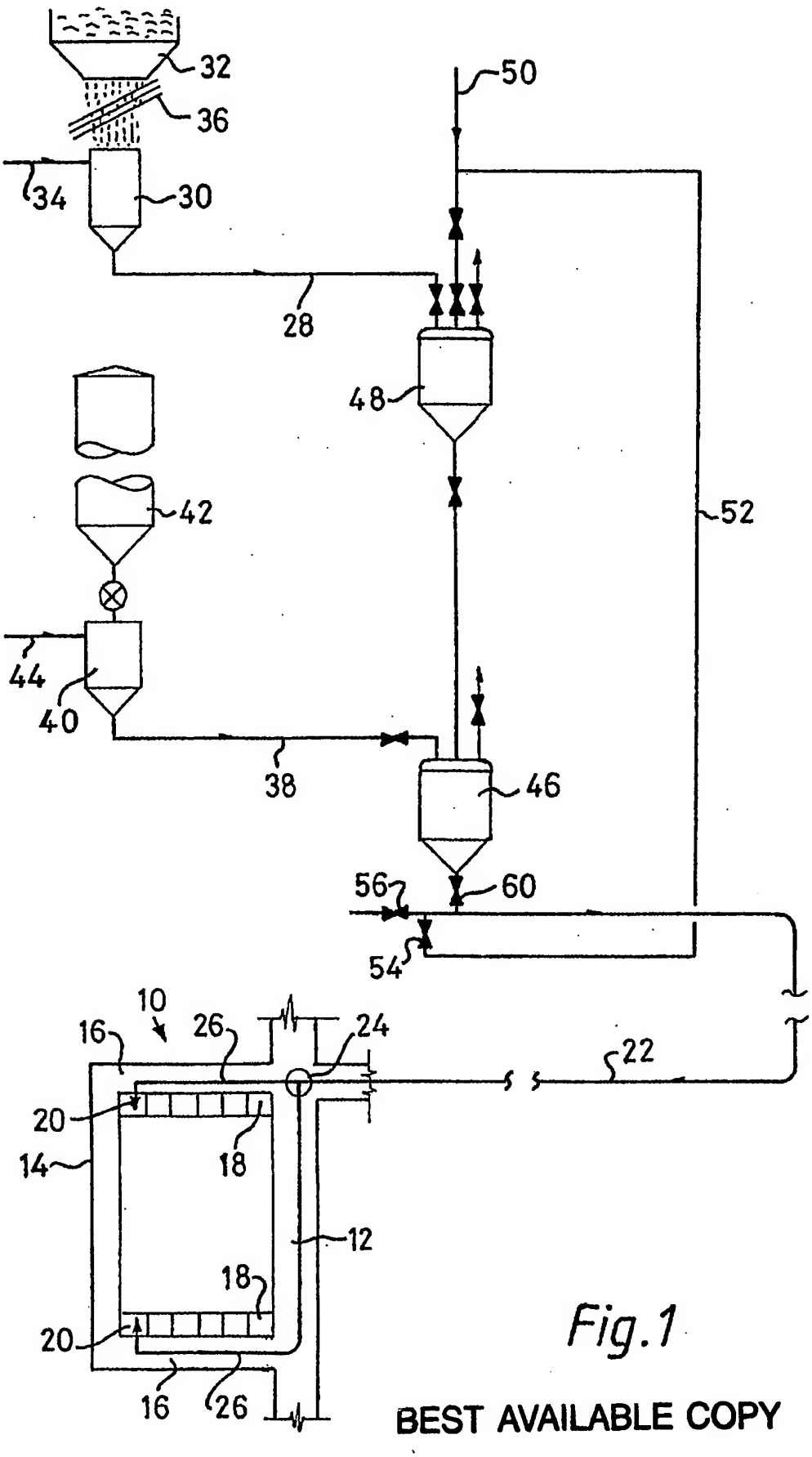

Fig.1

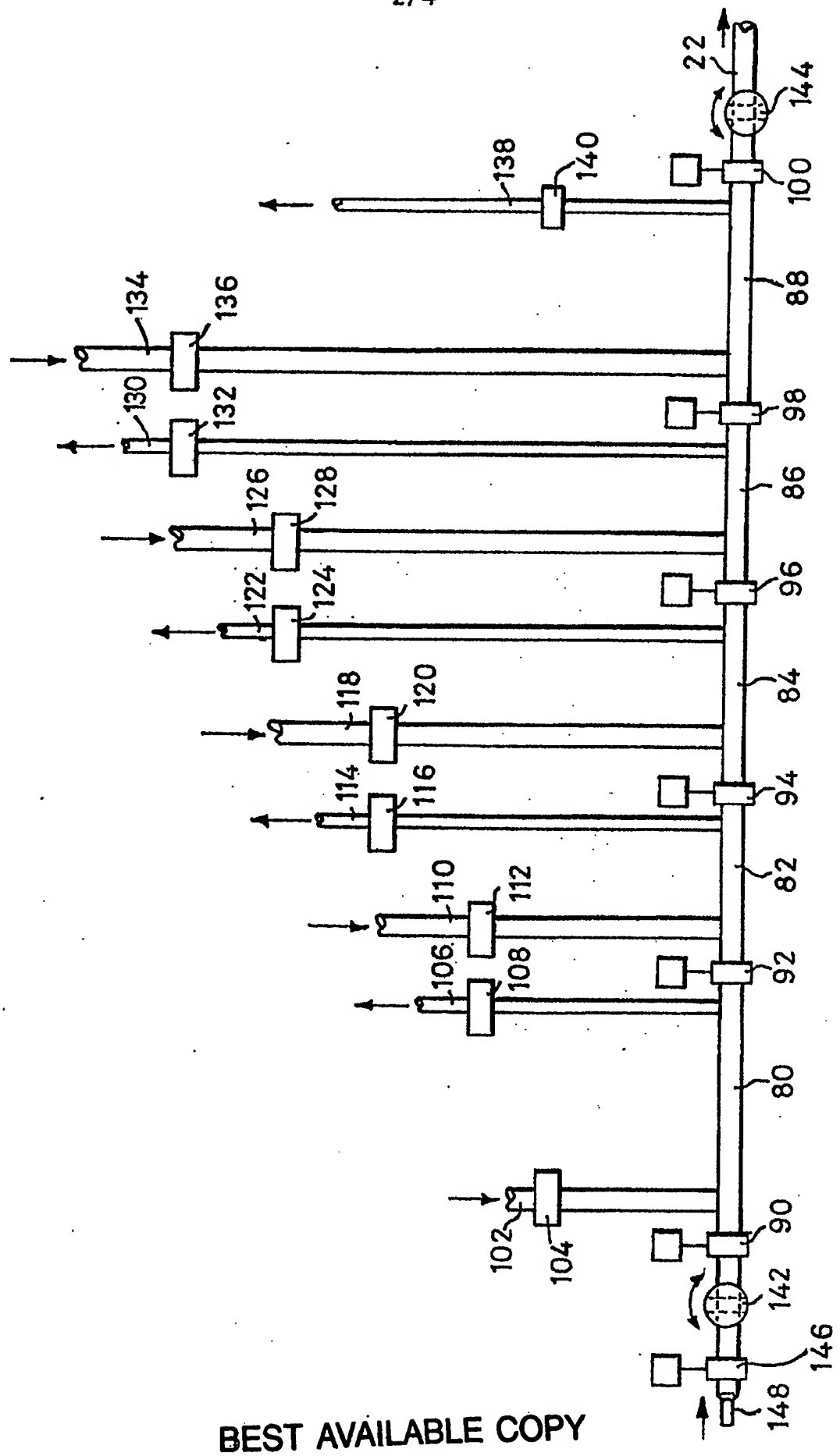

Fig.2

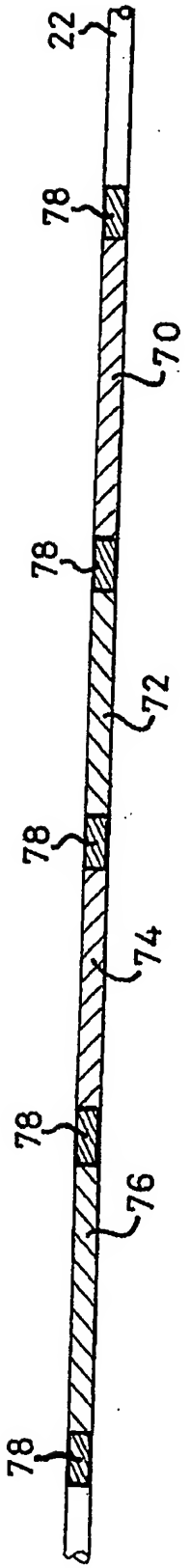

Fig.4

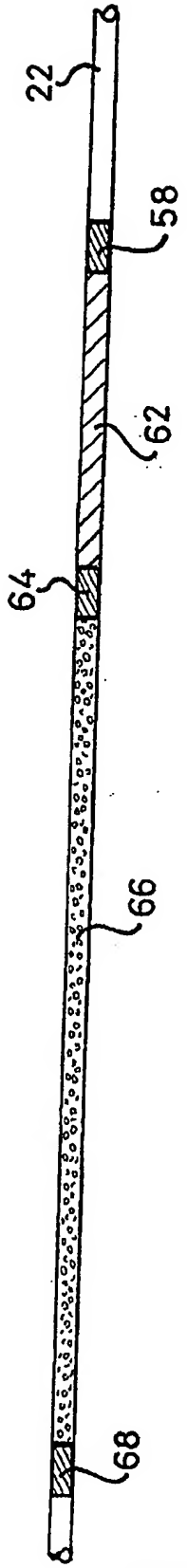

Fig.3

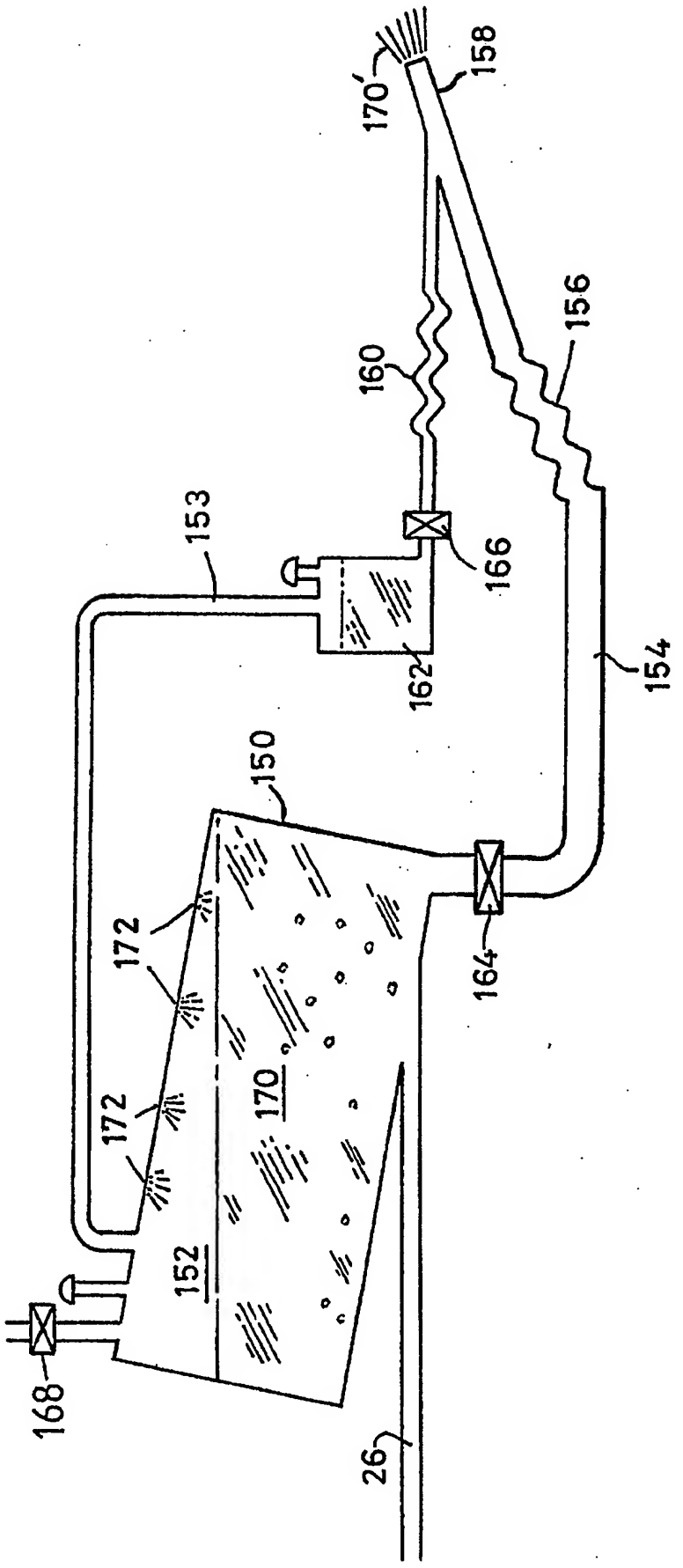

Fig.5

SPECIFICATION

Transporting materials through pipes

Field of the invention

This invention relates to transporting materials through pipes, particularly (but not exclusively) the transport of cementitious materials from the surface to an underground location in mines.

Background to the invention

In coal mining, as the coalface advances cementitious materials are used as the binding agents to make roof supports or so called packs alongside the access road leading from the trunk road tunnel to the coalface. Conventionally, the cement aggregate and water are transported separately from the ground surface to the coalface area where they are mixed together to form the concrete which is cast into the roadside packs. This process requires complex, bulky and expensive equipment underground where manpower is needed to operate and maintain the equipment. Further, it has been found that the consistency of the concrete, and therefore the ultimate strength of the packs, has varied as a result of the mixing being controlled by personnel underground. An object of the invention is to provide a method of and apparatus for transporting material which is particularly suitable for the transport of cementitious materials from the ground surface to a coalface in a coal mine, without the need for complex mixing equipment at the coalface.

Summary of the invention

According to one aspect the invention provides a method of transporting material through a pipe, comprising inserting into the pipe a first component comprising a settable material in liquid form, the first component forming a first body of material in the pipe, inserting into the pipe a second non-settable component forming a second body of material in a pipe adjacent to the first body, applying pressure to the pipe to cause the first body and the second body to move together along the pipe in the form of a slug with the first body leading the second body, whereby the second component acts to clean or scour the internal pipe wall of any residual first component which, but for the cleaning action of the second component, would harden on the internal wall of the pipe.

Hitherto, cementitious materials have not been premixed at the ground surface and then transported underground in the ready mixed condition because of the problem of the concrete tending to set in the long lengths of pipeline necessary. The invention overcomes this by arranging for the first and second components to be transported separately along the pipe, with the second non-settable component following the first settable component to ensure that the pipe is scoured and kept clean.

The first component preferably comprises a mixture of cement and water, called cementitious grout. The second component may be an aggregate slurry, ie a mixture of aggregate and water. Alternatively, the second component may be water along, in which case third and fourth components are preferably inserted into the pipe in sequence, the third component being a suitable additive (such as the material known as Aquabent) mixed with water and the fourth component being water alone. The four components then make up a slug of material which moves as a unit along the pipe as a result of the pressure applied thereto.

Adjacent components in a slug may be separated by intervening spacer members or "pigs" which may also be used at the leading and training end of each slug. The pigs may be of a resilient material, like sponge rubber or may alternatively be hollow and filled with an additive which is mixed with the components at the point of use. This may be achieved by providing the hollow pigs with a casing or covering which dissolves after a set time, or by providing means which break open the pigs where the components are finally mixed together at the point of use.

It will be understood that whilst the components travel along the pipe without substantial mixing, at the point of use effective mixing of the components take place as the latter are ejected with a velocity into the area of use which will normally be confined by shuttering or by a mould.

As mentioned, the method may be used to transport cement, water and aggregate from the ground surface to an underground location in a mine where the cement, water and aggregate are used for casting roadside packs which form a cast wall supporting the roof of the mine.

A number of slugs, each having the appropriate of components, may be transported in series along the pipeline by the application of pressure to the pipe, this conveniently being compressed air. By this means a roadside pack can be cast in position beside an access road leading to an advancing coalface in the same time as is used by conventional methods, but with only a single pipeline leading from the ground surface to the coalface area.

According to another aspect of the invention apparatus for transporting material through a pipe comprises means for inserting into the pipe a first component comprising a settable material in liquid form, the first component forming a first body of material in the pipe, means for inserting into the pipe a second non-settable component forming a second body of material in the pipe adjacent to the first body, and means for applying pressure to the pipe to cause the first body and the second body to move together along the pipe in the form of a slug with the first body leading the second body, whereby the second component acts to clean or scour the internal pipe wall of any residual first component which, but for the cleaning action of the second component, would harden on the internal wall of the pipe.

The invention will now be further described by way of example with reference to the accompanying drawings in which:-

Figure 1 is a schematic view illustrating how the invention may be used to transmit cementitious

aggregate from the ground surface to an underground location in a coal mine,

Figure 2 is a detailed view showing how the various components are inserted into a pipeline on the ground surface,

Figure 3 shows a portion of the pipeline with the material inserted therein,

Figure 4 is a view similar to Figure 3 but showing alternative materials, and

Figure 5 shows a modified way of delivering the material to form a cast wall underground.

Detailed description of the drawings

Figure 1 shows the underground portion 10 of a coalmine in plan view. A trunk road tunnel 12 communicates with the coalface 14 by two spaced access roads 16. To support pressures on the access road arising from extraction of the coal, walls 18 are cast alongside the access roads 16. The walls 18 are made of concrete and are cast in units or packs as the face 14 advances. In Figure 1 the packs being placed are as shown at 20.

Material to cast the walls 18 is delivered at the coalface area by a pipeline 22 which leads through a diverter valve 24 into two pipe branches 26 for casting the two walls 18 respectively. Cementitious material to cast the walls 18 is mixed at the ground surface and delivered through the pipe which extends from the surface, down the mine shaft to the coalface area.

On the ground surface an aggregate slurry is formed in a pipe 28 supplied by a mixer 30 fed with aggregate from an aggregate crusher 32 and water from a pipeline 34. The aggregate passes through a screen 36 before entering the mixer 30. Cementitious grout is formed in a pipeline 38 supplied from a mixer 40 fed by cement from a silo 42 and water through a pipeline 44. The cementitious grout is fed from the pipe 38 into a pressure vessel 46, and the aggregate slurry is fed from the pipe 28 into a further pressure vessel 48. The pressure vessels 46 and 48 may be pressurised by a source of high pressure air applied at 50; a branch 52 of the high pressure air line is connected through a valve 54 to the inlet end of the pipe 22.

To deliver cementitious material from the ground surface to the packs 20 a sponge plug or pig is first inserted into the inlet end of the pipe 22, after opening an appropriate valve 56. This leading pig is shown at 58 in Figure 3. A valve 60 is then opened and the high pressure air forces a quantity of cementitious grout from the vessel 46 into the pipe 22. This body of cementitious grout is shown at 62 in Figure 3. After the grout 62, a further pig 64 is inserted into the pipe 22. A quantity of aggregate slurry is now inserted into the pipe 22 from the pressure vessel 48. This body of aggregate slurry is shown at 66 in Figure 3. A third pig 68 is inserted into the pipe behind the body of aggregate slurry.

If valves 56 and 60 are now closed and valve 54 opened, high pressure air will force the composite slug shown in Figure 3 along the pipe 22, until the slug eventually reaches the pack 20 being cast. At the pack, the cement grout and the aggregate slurry are forced by the air pressure into the void to be filled by the cement, and this results in effective mixing of the cement grout and the aggregate slurry. Because the cement grout 62 is followed by two pigs 64 and 68 and a body of aggregate slurry 66, the pipe 22 is cleaned behind the cement grout 62 so that no residue of cement grout is left in the pipe.

It will be understood that Figure 3 shows one slug or unit of the components necessary. In practice several such slugs would be inserted into the pipe in series and transported in series along the pipe 22 by the air pressure.

Figure 4 shows an alternative arrangement in which four components are successively placed in the pipe 22, namely an Aquacem slurry 70, water 72, an Aquabent slurry 74 and a further body of water 76, adjacent components being separated by a sponge rubber pig 78 and the slug being terminated at each end by further pigs 78.

Figure 2 shows a more detailed view of the inlet end of the pipe 22, means being provided in Figure 2 for including certain additives in the materials being transported underground. The pipeline 22 is divided into sections 80, 82, 84, 86 and 88 by six valves 90, 92, 94, 96, 98 and 100. From the left hand side of Figure 2 the pipe 22 has the following communicating pipes: an inlet pipe 102 for supplying fine aggregate slurry through an inlet valve 104; an outlet pipe 106 for venting air from the pipe 22 through a valve 108; an inlet pipe 110 for admitting cement accelerator slurry to the pipe 22 through a valve 112; an outlet pipe 114 for venting air from the pipe 22 through a valve 116; an inlet pipe 118 for admitting coarse aggregate slurry to the pipe 22 through a valve 120; an outlet pipe 122 for venting air from the pipe 22 through a valve 124; an inlet pipe 126 for admitting viscosity increaser slurry to the pipe 22 through a valve 128; an outlet pipe 130 for venting air from the pipe 22 through a valve 132; an inlet pipe 134 for admitting cementitious grout slurry to the pipe 22 through a valve 136; and an outlet pipe 138 for venting air from the pipe 22 through a valve 140.

The sequence of operations is as follows:

a) valves 90,92,94,96,98 and 100 are closed

b)valves 108,116,124, 132 and 140 are opened to vent the pipe 22

c) the pipe sections 80, 82, 84, 86 and 88 are filled by opening valves 104, 112, 120, 128 and 136, respectively

d) valves 104, 112, 120, 128, 136, 108, 116, 124, 132, 140 are closed

e) pigs are inserted through openable pig placers 142, 144

f) valves 90, 92, 94, 96, 98 and 100 are opened

g) valve 146 is opened to admit high pressure air from the line 52 to cause the composite slug of material to move along the pipeline 22 to its destination at the pack being cast.

In Figure 1, the material transported along the pipe 22 is delivered directly into the packs by one or other of the pipe branches 26. Figure 5 shows a modification in which a pressure vessel 150 receives the slugs of material from the pipe branch

26 (or the main pipe 22). The slugs of material are delivered to the base of the vessel 150 wherein the material is mixed as a result of the swirling motion of the material as it enters the vessel from the pipe branch 26. Since the pipe 22 is pressurized, the space 152 in the vessel 150 becomes pressurized, and this pressure acts to force the mixed material through an outlet pipe 154 leading to a flexible delivery pipe 156 terminating in an outlet nozzle 158. Just upstream of the nozzle 158, an accelerator is added to the concrete mix by means of a flexible pipe 160 which is also pressurized from the space 152 through a pipe 153.

Whilst material is being delivered to the vessel 150 through the pipe branch 26, valves 164 and 166 are closed, and valve 168 is open. When the complete slug (or series of slugs) of material has entered the vessel 150, the valve 168 is closed and the contents 170 of the vessel become pressurized until the pressure in the space 152 equals the pressure in the pipe branch 26. The vessel 162 containing the accelerator is also pressurized. The valves 164 and 166 are then opened simultaneously and the cementitious mixture, mixed with the accelerator, is ejected as a jet 170 which will solidify rapidly on the surface onto which it is sprayed. When all the material has been ejected from the vessel 150, the valves 164 and 166 are closed and the valve 168 is opened to depressurize the vessels 150 and 162.

The sequence is then repeated until sufficient building material has been sprayed for the immediate purpose. The vessel 150 is then cleaned of the cementitious material clinging to the walls by means of water injected into the vessel 150 by water jets 172. With the valve 168 open and the valve 164 closed, the cleaning water flows out of the vessel 150. The apparatus is then put into a standby condition with the valve 169 open and the valves 164 and 166 closed. The supply of compressed air is then terminated by controls at the inlet end of the pipe 22.

Calculations show in a particular example of a pipe 22 having a diameter of 12 cms, an applied air pressure of 67 psig can drive a slug of material (like Figure 4 and occupying 470 feet of pipe) a distance of 12000 feet in a total transit time of 15 minutes. Each slug is ejected from the pipe 22 before a subsequent slug commences its travel along the pipe. Alternatively, a plurality of shorter slugs can be in transit simultaneously.

CLAIMS

1. A method of transporting material through a pipe, comprising inserting into the pipe a first component comprising a settable material in liquid form, the first component forming a first body of material in the pipe, inserting into the pipe a second non-settable component forming a second body of material in a pipe adjacent to the first body, applying pressure to the pipe to cause the first body and the second body to move together along the pipe in the form of a slug with the first body leading the second body, whereby the second component acts to clean or scour the internal pipe wall of any residual first component which, but for the cleaning action of the second component, would harden on the internal wall of the pipe.

2. A method according to claim 1, wherein the first component comprises a mixture of cement and water.

3. A method according to claim 2, wherein the second component is an aggregate slurry, ie a mixture of aggregate and water.

4. A method according to claim 2, wherein the second component is water alone.

5. A method according to claim 4, wherein third and fourth components are inserted into the pipe in sequence, the third component being a suitable additive (such as Aquabent) mixed with water and the fourth component being water alone, the four components then making up a slug of material which moves as a unit along the pipe as a result of the pressure applied thereto.

6. A method according to any of the preceding claims, wherein adjacent components are separated by intervening spacer members of "pigs".

7. A method according to claim 6, wherein pigs are also placed at the leading and trailing end of each slug.

8. A method according to claim 6 or 7, wherein the pigs are of a resilient material.

9. A method according to claim 6 or 7, wherein the pigs are hollow and filled with an additive which is mixed with the components at the point of use, by providing the hollow pigs with a casing or covering which dissolves after a set time, or by providing means which break open the pigs where the components are finally mixed together at the point of use.

10. A method according to any of the preceding claims, and for transporting cement, water and aggregate from the ground surface to an underground location in a mine where the cement, water and aggregate are used for casting roadside packs which form a cast wall supporting the roof of the mine.

11. Apparatus for transporting material through a pipe, comprising means for inserting into the pipe a first component comprising a settable material in liquid form, the first component forming a first body of material in the pipe, means for inserting into the pipe a second non-settable component forming a second body of material in the pipe adjacent to the first body, and means for applying pressure to the pipe to cause the first body and the second body to move together along the pipe in the form of a slug with the first body leading the second body, whereby the second component acts to clean or scour the internal wall of any residual first component which, but for the cleaning action of the second component, would harden on the internal wall of the pipe.

12. Apparatus according to claim 11, wherein a pressure vessel is located at the downstream end of the pipe to receive material transported along the pipe, the vessel communicating with a delivery pipe for delivering the material to the point of use.

13. A method of transporting material through a pipe, substantially as herein particularly described with reference to Figures 1 to 4, or as modified by Figure 5, of the accompanying drawings.

14. Apparatus for transporting material through a pipe, substantially as herein particularly described with reference to Figures 1 to 4, or as modified by Figure 5, of the accompanying drawings.

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